

1 1. A spinal fixation apparatus comprising:

2 a longitudinal rod;

3 a plurality of stem clamps mounted to said longitudinal
4 rod, each of said stem clamps comprising a clamp body having
5 a stem extending outwardly therefrom and an upper jaw and a
6 lower jaw, said upper jaw being resiliently joined to said
7 lower jaw through a cylindrical sidewall, said cylindrical
8 sidewall forming one portion of a lateral throughbore through
9 said clamp body for slidably receiving said longitudinal rod
10 in clamping relationship, said clamp body including a
11 transverse throughbore passing through said upper jaw and said
12 lower jaw, the portion of said transverse throughbore through
13 said lower jaw having threads therein, said stem clamp
14 including a bolt for passing through said transverse
15 throughbore and threadably engaging said threads in said lower
16 jaw thereby compressing said upper jaw toward said lower jaw
17 to securely anchor said stem clamp to said longitudinal rod;

18 a plurality of C-clamps mounted to said stems and to said
19 longitudinal rod, each of said C-clamps including a clamp body
20 having an upper jaw and a lower jaw resiliently connected to
21 said upper jaw through a cylindrical sidewall, said
22 cylindrical sidewall forming a lateral throughbore through
23 said clamp body for selectively receiving said longitudinal
24 rod and said stems, said clamp body including a transverse
25 throughbore through said upper jaw and said lower jaw, said
26 transverse throughbore including threads in said lower jaw; and

1 a bone screw for selectively securing said C-clamp to
2 said longitudinal rod and said stem, said bone screw also
3 mounting said C-clamp to bone, said bone screw having an
4 elongated screw body and a screw head, said screw body having
5 a distal end and a proximal end with said proximal end being
6 adjacent said screw head, said screw body having a reduced
7 diameter from said distal end to a diametrically enlarged
8 shoulder adjacent said screw head, said reduced diameter
9 passing through said transverse throughbore in said C-clamp in
10 a nonbinding relationship, said screw body having a first set
11 of threads with said diametrically enlarged shoulder having a
12 second set of threads, said second set of threads being
13 configured to threadedly engage said threads in said lower jaw
14 of said C-clamp.

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16 2. The spinal fixation apparatus defined in claim 1 wherein
17 said bone screw includes said first set of threads and said second
18 set of threads having an identical thread pitch.

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20 3. The spinal fixation apparatus defined in claim 2 wherein
21 said threads have an angled face toward said distal end and an
22 orthogonally oriented face toward said proximal end.

1 4. The spinal fixation apparatus defined in claim 1 wherein
2 said spinal fixation apparatus includes a second longitudinal rod
3 spaced from said longitudinal rod and with a second plurality of
4 said stem clamps mounted to said second longitudinal rod, a second
5 plurality of said C-clamps mounted to said stems of said second
6 plurality of said stem clamps, and a second plurality of said bone
7 screws mounting said C-clamps to the bone.

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9 5. The spinal fixation apparatus defined in claim 4 wherein
10 said spinal fixation apparatus includes a cross-link plate mounted
11 between said longitudinal rod and said second longitudinal rod,
12 said cross-link plate having a first end and a second end with a
13 first eyelet formed in said first end and a second eyelet formed in
14 said second end, said cross-link plate having a shank extending
15 between said first eyelet and said second eyelet, said shank having
16 a square profile at the midsection of said shank.

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18 6. The spinal fixation apparatus defined in claim 1 wherein
19 said C-clamp includes an angular offset of said lower jaw from said
20 upper jaw, said angular offset having an angle within the range on
21 the order of about one degree to ten degrees.

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23 7. The spinal fixation apparatus defined in claim 1 wherein
24 said C-clamp includes a detent means as an engagement means on said
25 C-clamp.

1 8. The spinal fixation apparatus defined in claim 1 wherein
2 said stem clamp includes an angular offset of said lower jaw from
3 said upper jaw, said angular offset having an angle within the
4 range on the order of about one degree to ten degrees.

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6 9. The spinal fixation apparatus defined in claim 1 wherein
7 said longitudinal rod includes a right angle bend formed in said
8 longitudinal rod.

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10 10. The spinal fixation apparatus defined in claim 1 wherein
11 said stem on said stem clamp is of the same diameter as said
12 longitudinal rod.

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14 11. The spinal fixation apparatus defined in claim 1 wherein
15 said C-clamp includes a bone pin for temporarily mounting said
16 spinal fixation apparatus to the spine prior to inserting said bone
17 screws into the spine.

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19 12. The spinal fixation apparatus defined in claim 11 wherein
20 said bone pin comprises a handle segment for hand grasping said
21 bone pin and a pin segment for insertion through said C-clamp and
22 into the bone of the spine, said bone pin thereby releasably
23 mounting said C-clamp to the spine.

1 13. A spinal fixation apparatus for implantation on a spine
2 comprising:

3 a first longitudinal rod for placement on the spine at
4 one side of and generally parallel to the spinous process of
5 the spine;

6 a second longitudinal rod for placement on the spine at
7 the other side of and generally parallel to the spinous
8 process of the spine;

9 a plurality of stem clamps mounted to said first
10 longitudinal rod and said second longitudinal rod;

11 a plurality of C-clamps mounted to said stem clamps and
12 to said first longitudinal rod and to said second longitudinal
13 rod;

14 a plurality of bone screws mounted to said C-clamps, said
15 bone screws securing said C-clamps to the spine; and

16 at least one cross-link plate interconnecting said first
17 longitudinal rod to said second longitudinal rod.

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19 14. The spinal fixation apparatus defined in claim 13 wherein
20 each of said first longitudinal rod and said second longitudinal
21 rod includes a right angle bend.
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1 15. The spinal fixation apparatus defined in claim 13 wherein
2 said stem clamp comprises a clamp body having an upper jaw and a
3 lower jaw with a lateral throughbore passing between one edge of
4 said clamp body, said throughbore telescopically receiving said
5 first to second longitudinal rods, said clamp body including a
6 transverse throughbore passing orthogonally through said upper jaw
7 and said lower jaw with the portion of said transverse throughbore
8 through said lower jaw having threads therein, said clamp body
9 including a stem extending orthogonally therefrom, said stem clamp
10 including a bolt means for threadedly engaging said threads to
11 bring said upper jaw toward said lower jaw and constrict said
12 lateral throughbore thereby securing said stem clamp to said
13 longitudinal rod.

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15 16. The spinal fixation apparatus defined in claim 13 wherein
16 said C-clamp comprises a clamp body having an upper jaw and a lower
17 jaw with a lateral throughbore passing between said upper jaw and
18 said lower jaw, said clamp body having a transverse throughbore
19 passing orthogonally through said upper jaw and said lower jaw with
20 the portion of said transverse throughbore in said lower jaw having
21 threads therein.

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17. The spinal fixation apparatus defined in claim 16 wherein said C-clamp includes engagement means for engaging said C-clamp with said bone screw, said bone screw comprising a bolt head at a proximal end and a tip at a distal end, said bone screw having a threaded shaft between said proximal end and said distal end with said threaded shaft having a threaded, diametrically enlarged shoulder adjacent said bolt head and a threaded, diametrically reduced screw body between said shoulder and said tip, the thread pitch for said threaded, diametrically enlarged shoulder being identical to said threaded, diametrically reduced screw body, said threaded, diametrically enlarged shoulder threadedly engaging said threads in said transverse throughbore in said lower jaw of said C-clamp thereby providing said engagement means for said C-clamp.

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18. The spinal fixation apparatus defined in claim ¹³~~17~~ wherein said upper jaw includes an angular offset from said lower jaw to accommodate being compressed downwardly upon tightening with said bone screw, said angular offset comprising an angle within the range on the order of about one degree to ten degrees.

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19. The spinal fixation apparatus defined in claim 13 wherein said stem clamp includes a lower jaw and an upper jaw, said lower jaw having an angular offset from said upper jaw, said angular offset being within the range on the order of about one to ten degrees.

1 20. The spinal fixation apparatus defined in claim 13 wherein
2 said bone screw comprises a screw having a head at a proximal end
3 and a tip at a distal end, said screw having a diametrically enlarged
4 shoulder adjacent said head, said shoulder having a first set of
5 threads, said screw including a shaft extending between said
6 shoulder and said tip, said shaft being diametrically smaller than
7 said shoulder and having a second set of threads, said second set
8 of threads having the same thread pitch as said first set of
9 threads.

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11 19/ 21. The spinal fixation apparatus defined in claim 18 wherein
12 said second set of threads includes a thread profile having a
13 planar face orthogonal to the axis of said shaft, said planar face
14 being oriented toward said head.

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16 22. The spinal fixation apparatus defined in claim 13 wherein
17 said C-clamp includes a bone pin for temporarily mounting said C-
18 clamp to the spine prior to inserting said bone screw, said bone
19 pin having a handle and a pin extending therefrom, said pin having
20 a reduced diameter to pass through said C-clamp and into the bone.
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21/23 A method for providing fixation of a spine comprising the
steps of:

obtaining a longitudinal rod;
preparing a plurality of stem clamps with stems extending
therefrom;
mounting said stem clamps to said longitudinal rod;
fabricating a plurality of C-clamps;
affixing said C-clamps to said longitudinal rod and to
said stems of said stem clamps;
forming a plurality of bone screws;
securing said C-clamps to a spine with said bone screws;
and
tightening said stem clamps and said C-clamps thereby
providing spinal fixation with said longitudinal rod.

24. The method defined in claim 23 wherein said fabricating
step comprises preparing said C-clamp as a pair of opposed jaws
having a lateral throughbore therethrough for slideably receiving
said longitudinal rod or said stem of said stem clamp, said
preparing step including forming a transverse throughbore through
said upper jaw and said lower jaw and creating a set of threads in
the lower jaw portion of said transverse throughbore.

1 25. The method defined in claim 23 wherein said fabricating
2 step includes forming said plurality of bone screws with a first
3 threaded section and a second threaded section, said first threaded
4 section having a smaller diameter sufficient to pass through said
5 transverse throughbore in said C-clamp, said second threaded
6 section threadedly engaging said set of threads in said C-clamp
7 thereby selectively clamping said C-clamp to said longitudinal rod
8 and said stem.

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10 26. The method defined in claim 23 wherein said obtaining
11 step includes providing a second longitudinal rod and affixing said
12 second longitudinal rod to the spine along with said longitudinal
13 rod using said stem clamps, said C-clamps, and said bone screws.

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15 *25* 27. The method defined in claim 26 wherein said providing
16 step includes coupling said longitudinal rod to said second
17 longitudinal rod with a cross-link plate.

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19 *24* 28. The method defined in claim 27 wherein said coupling step
20 includes forming said cross-link plate with a first end and a
21 second end and a first eyelet in said first end and a second eyelet
22 at said second end, said forming step including providing a shank
23 between said first eyelet and said second eyelet, said providing
24 step including forming said shank with a square cross-sectional
25 profile thereby deformably adjusting said cross-link plate to said
26 longitudinal rod and said second longitudinal rod.

5 967 1 29. The method defined in claim 23 wherein said forming step
2 includes preparing threads on said bone screw for securely engaging
3 bone with said threads, said preparing step including shaping said
4 threads with a generally flat surface orthogonal to the axis of
5 said bone screw, said flat surface being oriented to the outer
6 surface of the bone as said bone screw is inserted into the bone.
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8 30. The method defined in claim 23 wherein said affixing step
9 includes obtaining a plurality of bone pins and ascertaining the
10 placement of said longitudinal rod, said stem clamps, and said C-
11 clamps prior to said securing step by mounting said C-clamps to the
12 spine with said bone pins.
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